Regulating GHG Emissions in CA: Issues in Regulatory Design

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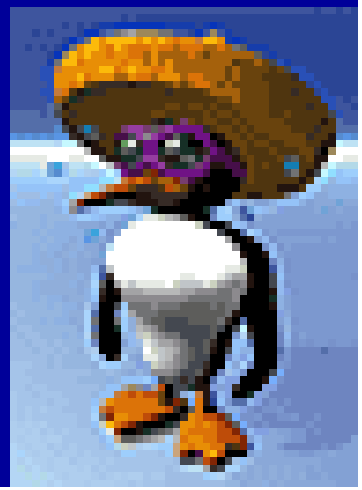
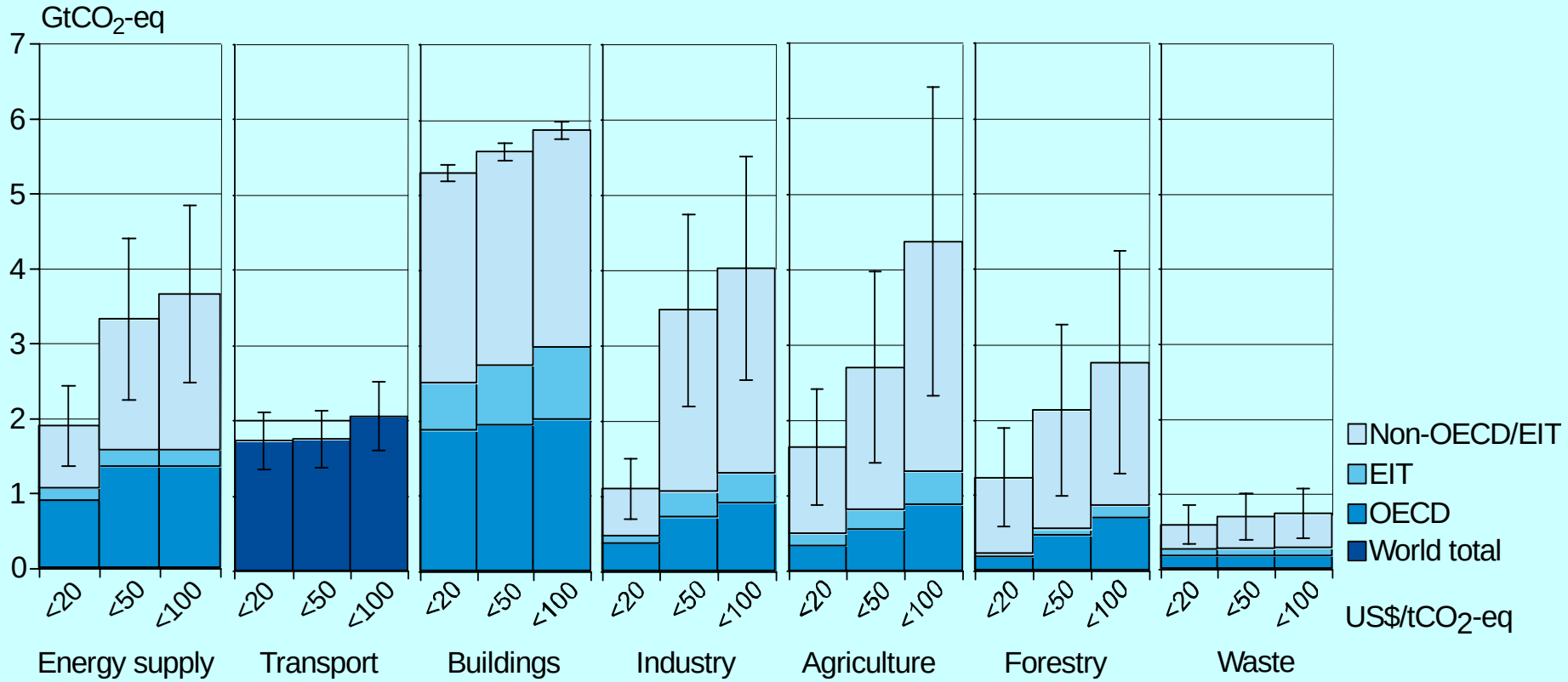
Prof. Charles D. Kolstad
Program in Environmental Economics
Bren School of Environmental Science & Management
University of California, Santa Barbara
www.ckolstad.org

An Economist's View of Climate Change

- Paradigm: a balancing of conflicting societal goals
  - Benefits of being proactive: environmental, economic, indirect (providing leadership to other polluters)
  - Costs of being proactive: additional costs to California consumers, leakage, risk of failure
  - Adapt – undertake actions to buffer the state from possible negative consequences of climate change
- What's important
  - Act to achieve most environmental bang for buck
  - Act soon but not too quickly – ratchet up actions over time
  - Allow flexibility in who mitigates by how much
  - Regulate wide and deep
  - Incentivize consumers, firms, innovators
  - Pay attention to regulatory efficiency AND incidence



Importance of a Carbon Price



Estimated mitigation potential at sectoral level in 2030 from bottom-up studies (Source: IPCC AR4, WGIII)

Note: bottom-up studies underestimate sensitivity to carbon price.

Economists' Nightmares

- Regulations act too quickly, causing capital to be prematurely abandoned
- Regulations delayed until problem becomes severe rather than ratcheting up slowly starting now
- Regulations keep changing or may change, reducing firm incentives to commit
- Excessive command-and-control with inadequate incentives
- Inadequate flexibility among sectors
  - Philosophy of "change the auto companies" drives up costs with little environmental benefit
- Non-carbon concerns overtake regulatory process
  - Equity addressed through costly regulatory structure rather than directly
  - Lifestyles of the "other" classes become a target
- BIGGEST nightmare: California regulations so poorly designed that AB32 falls apart and sets back climate policy worldwide

Outline of the Talk

- Basic questions
  - How to design GHG regulations in CA?
  - How to evaluate proposed GHG regulations?
- Focus on two subissues in the talk
  - Designing regulations to promote innovation
  - Evaluating the incidence of regulations (who benefits and who loses)

IPCC AR4 WGIII Criteria for Evaluating GHG Regulations

- Economic effectiveness
- Environmental effectiveness
- Distributional consequences

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- Economic effectiveness
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- Environmental effectiveness
  - Need to achieve environmental gains—no repeat of Kyoto
- Distributional consequences
  - Pay attention to regulatory INCIDENCE
  - Avoid concentrated costs and benefits to any group.

So we regulate… How will economy respond?

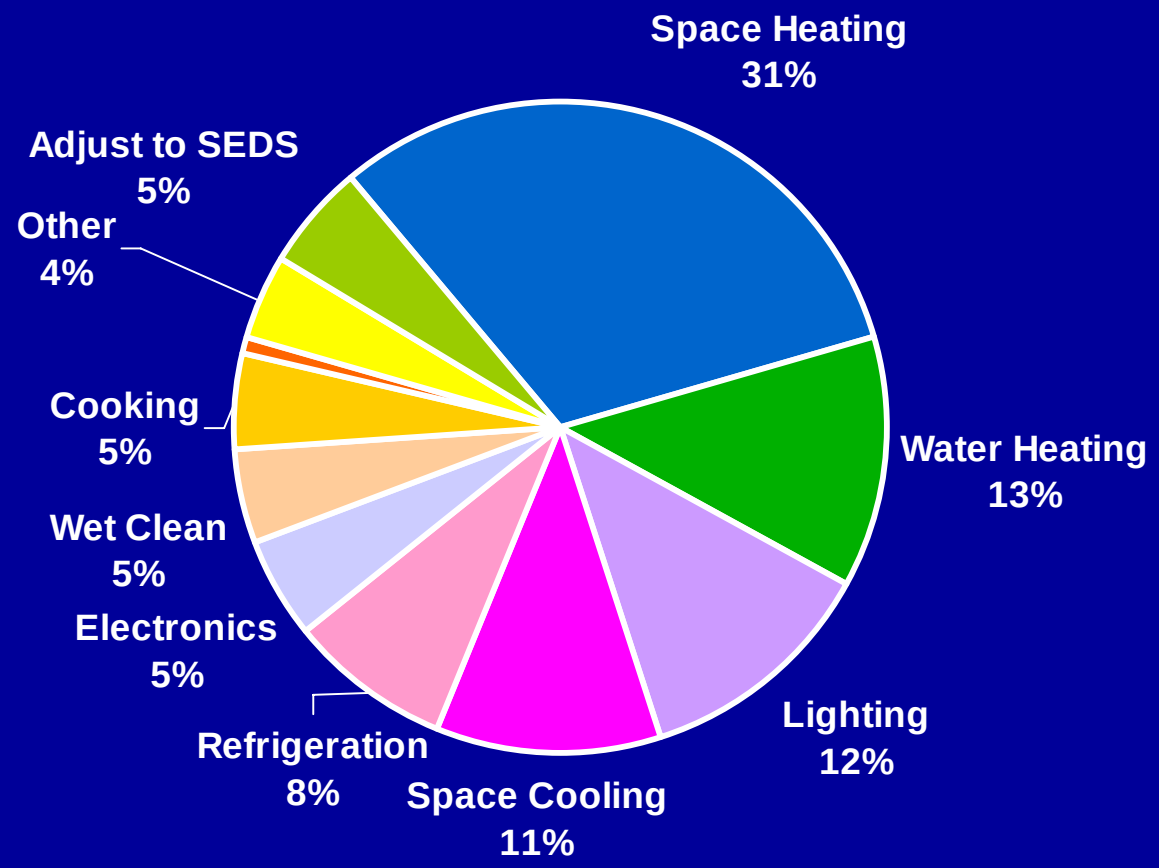
- By applying existing technology
  - Buy more fuel efficient cars
  - More compact fluorescent lightbulbs
  - Higher efficiency electricity generation
  - Fuel switching (to natural gas)
- By behavioral change
  - Drive less
  - Change house location
  - Buy smaller house
  - Buy more green products
- By technological change
  - Vehicle fuel efficiency improvements
  - Advances in LED lighting
  - Battery technology
  - ?

Effective Regulations must

- Send strong and consistent signals
  - Regulations that may change will not induce investment
- Induce polluters (individuals and firms) to adopt appropriate current technology
- Send an effective signal to polluters to look for ways of reducing carbon
- Induce polluters to change behavior (for individuals) or processes (for firms)
- Reward innovators for broadening the landscape of technological options
- Reward commercializers of carbon-saving technologies

Example: Reducing Residential Energy Consumption.

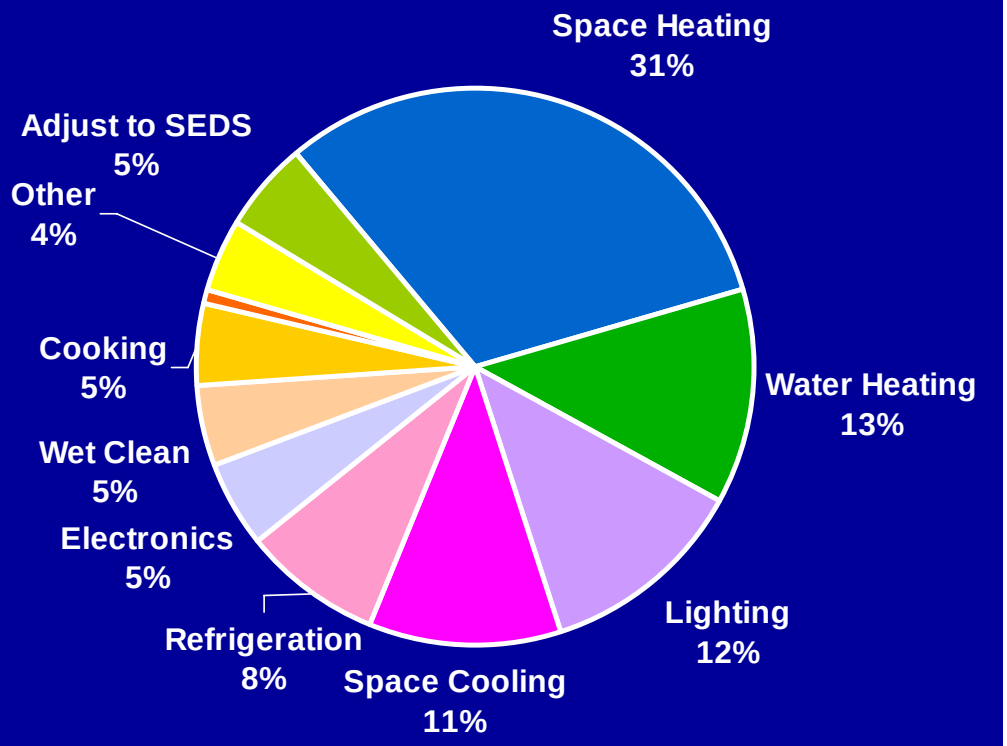
U.S. Residential Buildings Energy End-Use, 2004



Total Energy Consumption: 21.07 Quadrillion Btu

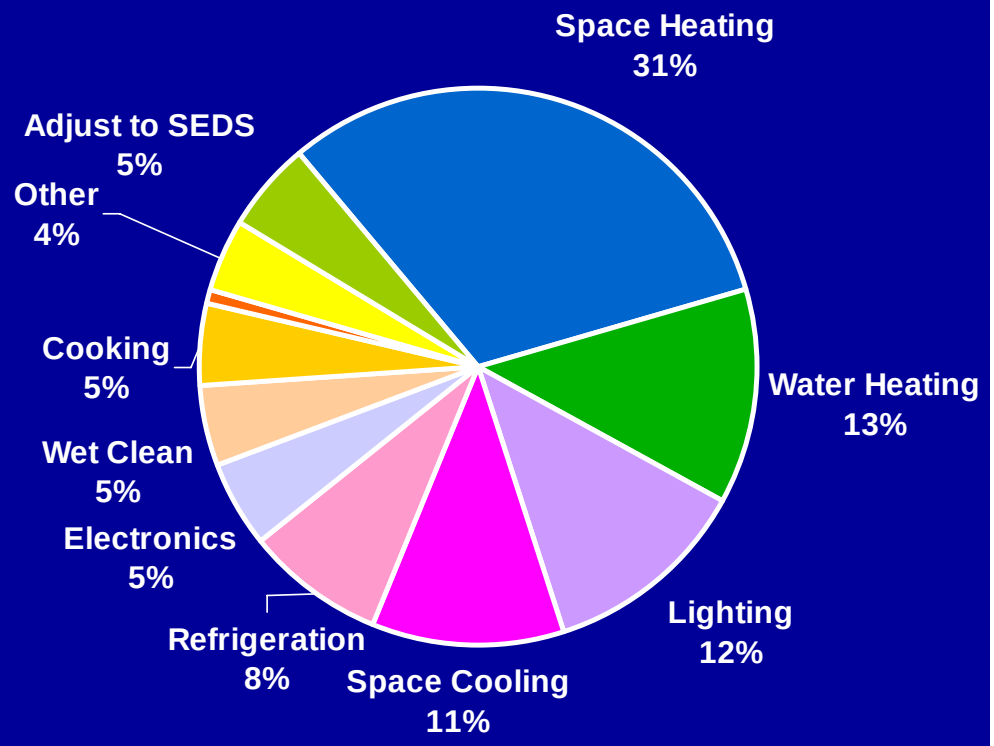
Source: EIA

Technological options



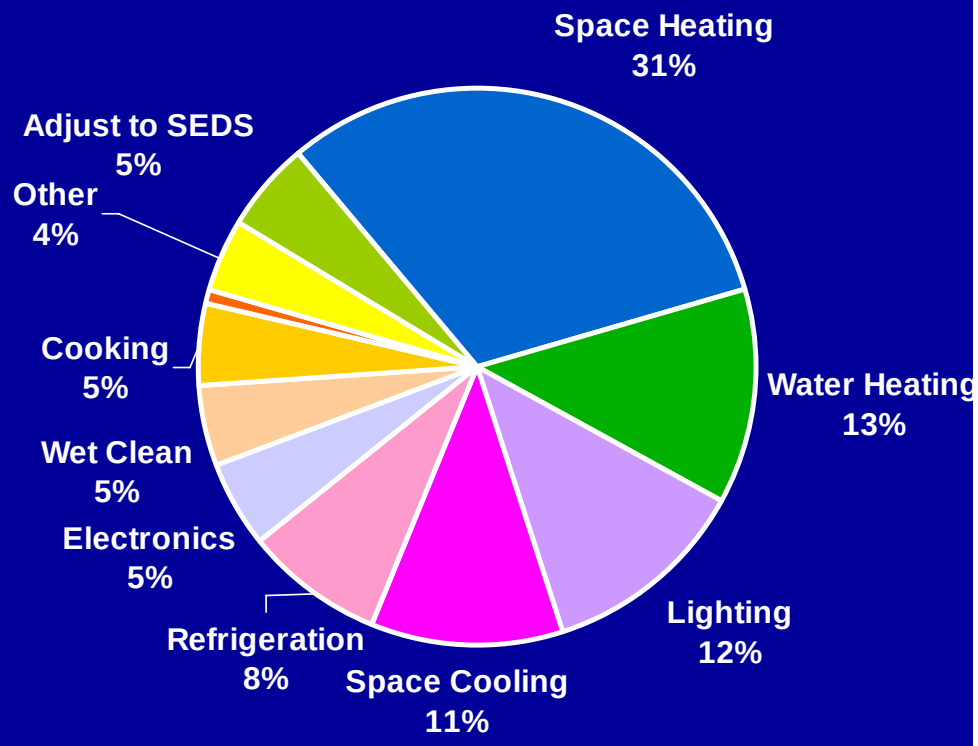
- Space heating & AC:
  - More insulation
  - Higher efficiency furnaces
  - On-demand water heating
- Lighting
  - Compact fluorescent light bulbs
- Refrigeration
  - Higher efficiency

Behavioral options



- Space heating & AC:
  - Less space conditioning
  - Move to milder climate
  - Downsize house
  - Change lifestyle
- Lighting
  - Not much
- Refrigeration
  - Downsize

Innovation opportunities

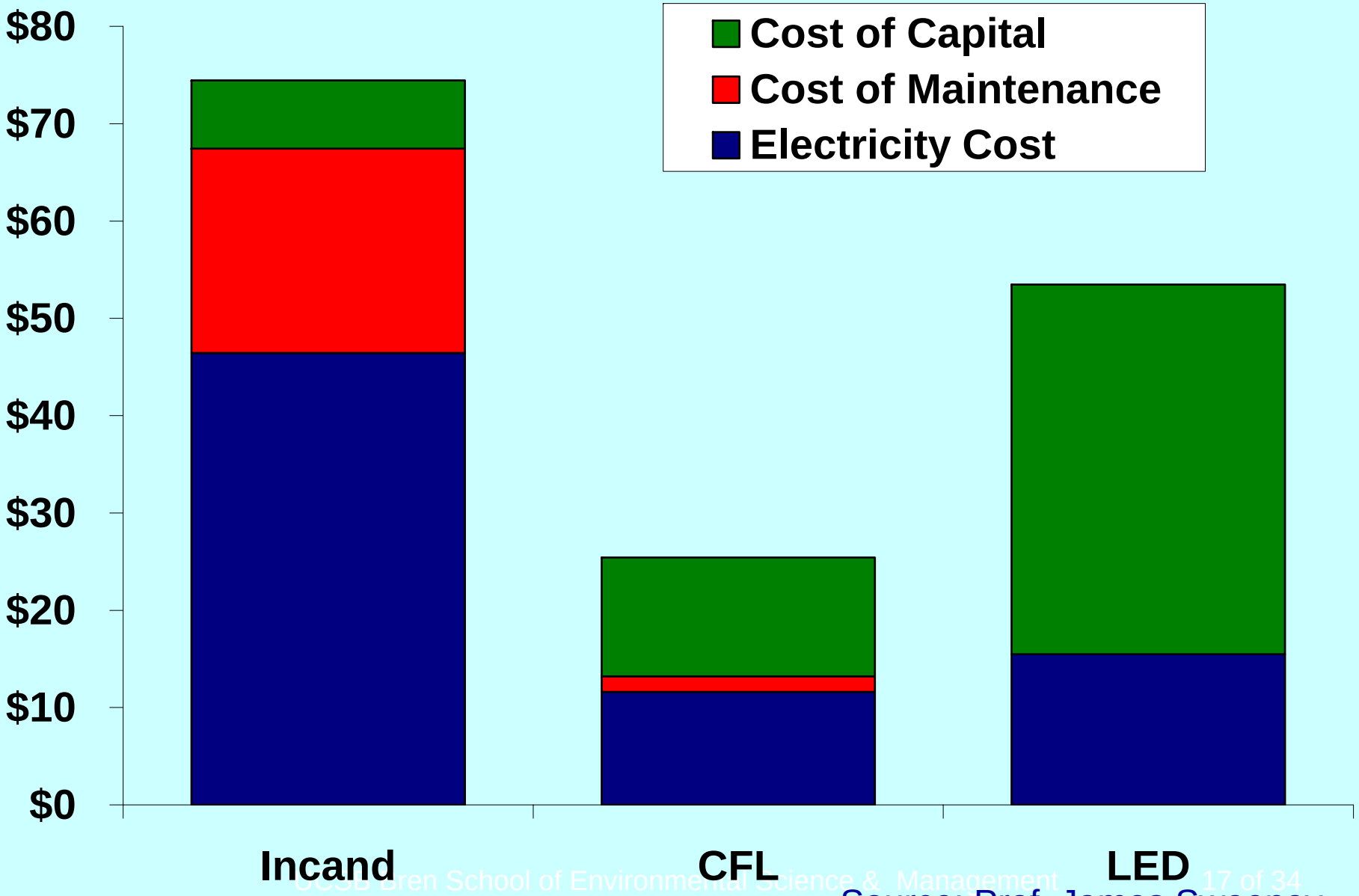


- Space heating & AC:
  - Higher efficiency furnaces
  - Methods for retrofit insulation
  - Innovative ways of heating (eg, microwaves)
- Lighting
  - LED replacement lighting
- Refrigeration
  - Ultra High efficiency
  - Time of day

Closer look at innovation

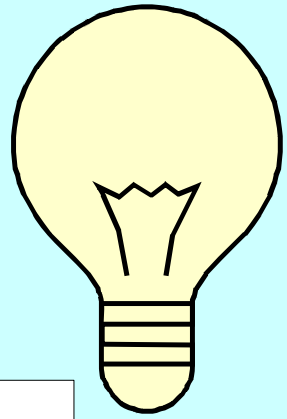
State regulations alone may
have problems encouraging innovation

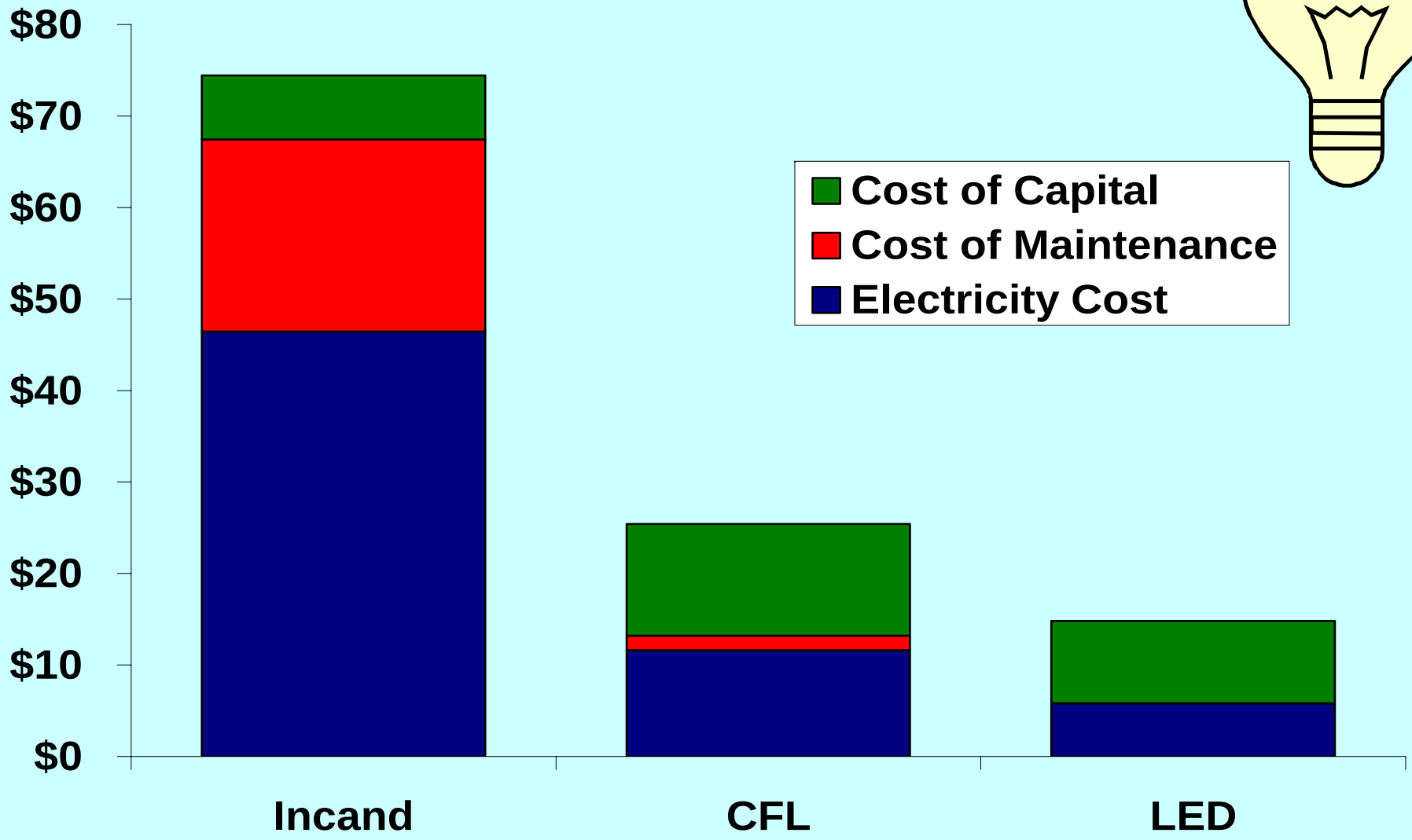
EXAMPLE: Residential 900 Lumen Lighting
20 year Lifecycle Cost (Now)



Source: Prof. James Sweeney

WITH Innovation for 2015: Residential 900 Lumen Lighting
20 year Lifecycle Cost





Source: Prof. James Sweeney

Innovation Opportunities

- Increase efficiency of delivering current services – lights, refrigeration, space conditioning, kinetic energy, transportation
- Improved battery storage could have major effect
- Improve quality of current high-efficiency technologies (eg, CFL and LED)
- Change the way we live our lives – internet, video linking
- Supply innovation – improve sources of energy vis-à-vis GHG
- Adaptation – improve the way we deal with changes in climate and volatility of weather
- Social science research – better understand how people are affected by climate change and adapt to climate change
- Adaptation poorly understood

How to induce innovation and commercialization of innovations

- Direct government funding of R&D
- Technology-forcing regulation
- Best-in-class regulation (eg, Japan's Toprunner)
- Feebate systems for pushing efficiency
- Prizes for inventions
- Subsidies to early adopters
- IMPORTANT: consumers must see value to innovation

How well have these worked?

- Direct government funding of R&D
  - Surprising unsuccessful except for basic research

How to Induce Innovation

- Direct government funding of R&D
- Technology-forcing regulation
  - Can be very effective
  - Cannot push envelope too far or political process may derail—difficult to find right balance
  - Cannot be continually used--subject to ratchet effect

How to Induce Innovation

- Direct government funding of R&D
- Technology-forcing regulation
- Best-in-class regulation
  - Has worked well in Japan (limited applications)
  - Requires a well-defined consumption category
  - Eg, require new cars to achieve highest demonstrated fuel efficiency

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  - Eg, gas guzzler fee supplemented by subsidies to high efficiency car purchases

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- Prizes for inventions
  - Can be very effective
  - Has failed when not accompanied by incentives to consumers (eg, Golden Carrot)

How to Induce Innovation

- Direct government funding of R&D
- Technology-forcing regulation
- Best-in-class regulation (eg, Japan's Toprunner)
- Feebate systems for pushing efficiency
- Prizes for inventions
- Subsidies to early adopters
  - Effectively used for solar energy
  - Can be very costly

Closer Look at Prizes

- Some famous prizes
  - £20,000 prize for measuring latitude (1714)
  - 12,000 franc prize for military food preservation (1810)
  - 50,000 Franc prize for motorized flight (1900)
  - £50,000 for human powered flight (1977)
  - $1 million prize for removing As in drinking water (2007)
  - $30 million Golden Carrot – refrigerators (1993)
- NSF pushing prizes
- National Academy of Sciences (2007): *Innovation Inducement Prizes*

The Golden Carrot

- Prize to manufacturer which developed CFC-free refrigerator, 25% more efficient that federal efficiency standards
- Prize paid through subsidies to sales
- Financed by certain utilities based on sales in their service territory
- Refrigerator failed to penetrate the market because of low energy costs
  - Prize can be effective at inducing an *invention*
  - Prize less effective for spurring commercialization or cost reduction
  - Consumer rebates can achieve same effect
  - Invention will not penetrate without incentives for consumer (eg, high carbon cost)
- Were undoubtedly spillovers to other refrigerators and manufacturers

Closer look at regulatory incidence

work with PhD student

Corbett Grainger

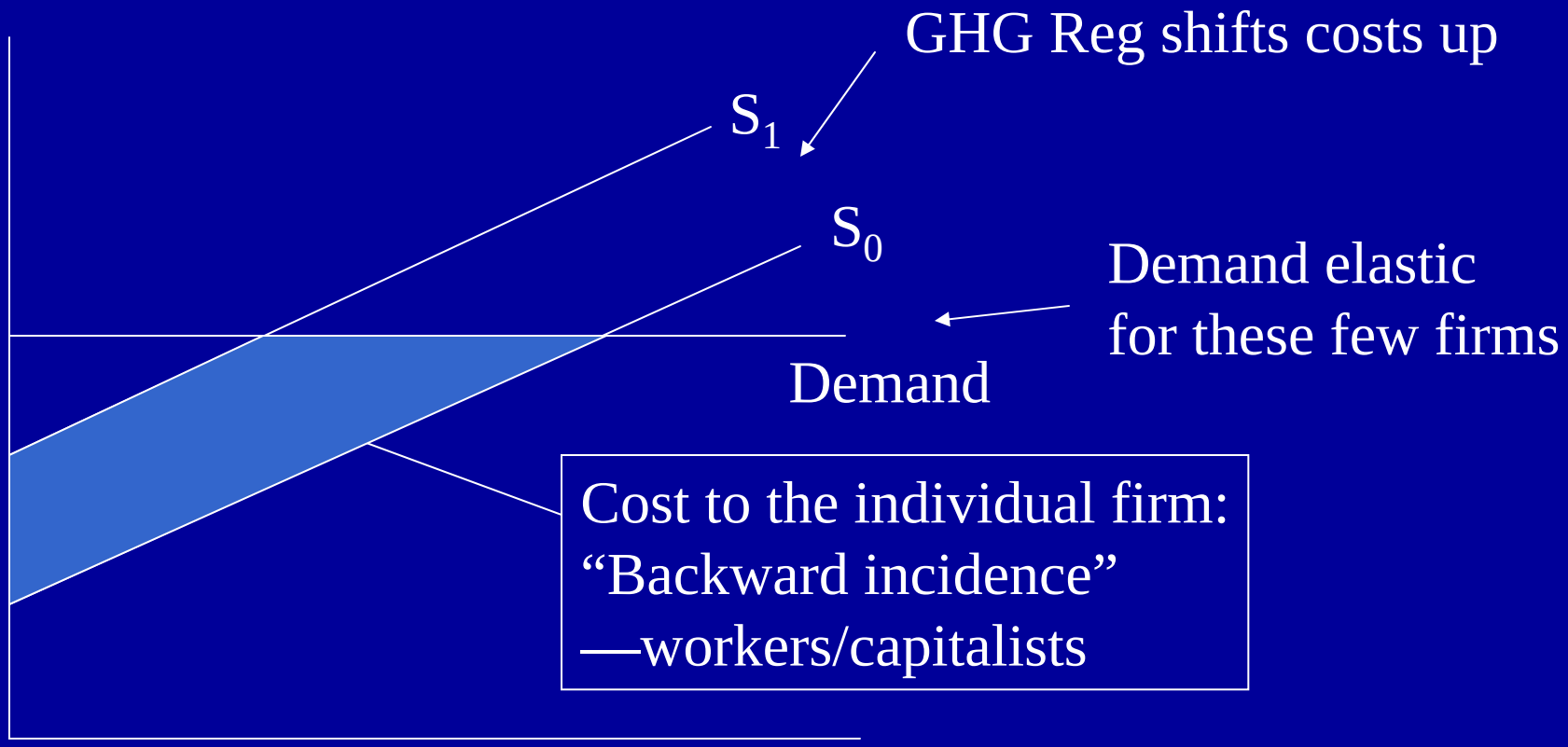
Recall tax incidence

- Who bears the cost of a tax on a firm?
  - Backwards incidence (factors of production)
    - Capital owners
    - Labor
    - Other fixed factors
  - Forward incidence (customers)
  - Other classes
    - Rich/poor
    - Race
    - Geography (eg, SoCal vs NoCal)
    - In state vs. Out of state
- Depends on
  - Relevant market
  - Price elasticities
  - Options for factors and consumers

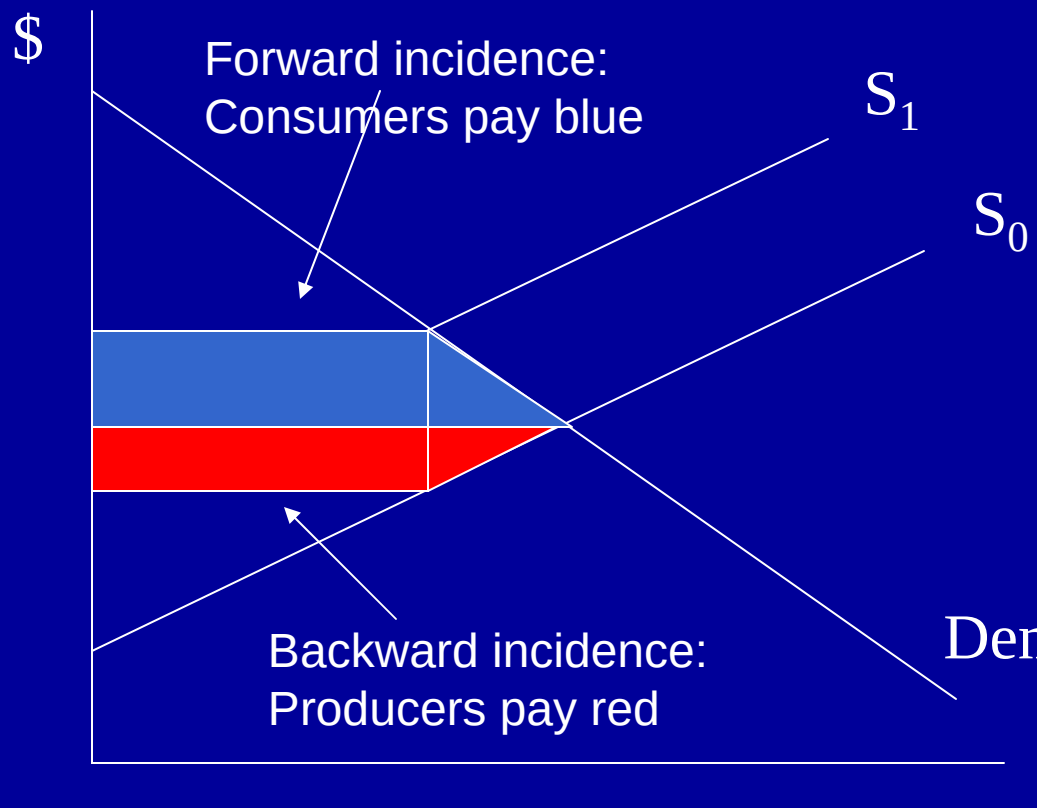
Extend to Incidence of a Regulation

- Regulation increases costs for firm (or individuals)
- Firms respond by reducing emissions but some costs remain
- Costs MUST be passed on to SOMEBODY
  - Corporations NEVER bear a cost
  - Owners, workers or customers always pay
  - Owners may live anywhere (eg, where are stockholders of PG&E?)
  - Workers typically live locally (ie, workers of California firms typically live in California)
  - Customers may or may not live in state

Case 1: Reg affects few firms in larger (eg, national) relevant market For example: manufacturing



Case 2: Reg covers all firms in a relevant market
Eg, California generators of electricity



Regulation raises costs: Supply shifts up, Price rises, quantity declines: forward and backward incidence

Lessons for Developing Regulatory Impact Model for California GHG Emission Control

- Need ability to evaluate economic efficiency/costs of different regulations
- Need to be able to evaluate effectiveness in reducing GHG emissions
- Need to be able to measure the incidence on different groups - positive and negative
  - In-state vs. Out-of-state
  - Locational
  - By income class
- At minimum: impact on median income Cal resident—gain or loss?